ENVSCI670: Ocean Biogeochemical Cycles Syllabus

Instructor: Prof. Jesse Farmer
email: jesse.farmer@umb.edu
Office hours: TBA & by appointment on Zoom

Course meeting: MW 2:30-3:45pm W01-0009

Course Format: The course will be a combination of lectures and discussions on current and foundational literature. The course meets twice weekly.

General Course Description:

Ocean Biogeochemical Cycles provides a quantitative treatment of the cycling of biologically important elements in the ocean in the present and past. This course examines the two-way interactions between marine ecosystems and their chemical environment, and their implications for the distributions of carbon, oxygen, nutrients, and trace metals in the ocean. A particular focus is on the ocean's carbon cycle, and the role that organisms and ocean circulation play in regulating the carbon dioxide content of the atmosphere over geologic time.

Goals and Specific Objectives:

Students should be able to demonstrate their knowledge and ability to:

(1) Quantitatively define the factors controlling the concentration and distribution of dissolved chemical species within the sea, the chemical fluxes at the ocean-atmosphere and ocean-sediment interfaces,

(2) Describe the interactions of ocean biogeochemical cycles with the physical climate system and biodiversity, and how anthropogenic perturbations force and are modified by ocean biogeochemistry

(3) Critically read, interpret, master, and, through course presentations, communicate primary literature, data, and emergent concepts in ocean biogeochemistry.

Combined Graduate and Undergraduate course: This course will be meeting in concert with an undergraduate level Ocean Biogeochemical Cycles course. The graduate students will often lead class discussions and will assist undergraduate students with reviews of draft final projects. The graduate section will have different assignments and will be graded separately from the undergraduate section.

Course Bibliography:

Textbook: Sarmiento, J.L. and Gruber, N. (2006). *Ocean Biogeochemical Dynamics*. Princeton: Princeton University Press. ISBN: 9780691017075.

Although almost two decades old, Sarimento and Gruber remains the authoritative textbook for understanding the couplings within and between ocean biogeochemistry and the Earth system.

Suggested texts for supplementary reading:
Emerson, S.R. and Hamme, R.C. (2022) *Chemical Oceanography: Element Fluxes in the Sea*. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781316841174.

Zeebe, R.E. and Wolf-Gladrow, D. (2001). *CO_2 in seawater: equilibrium, kinetics, isotopes*. Elsevier, ISBN 9780444509468.

Other readings will be provided from primary literature throughout the semester.

Course Digital Presence

The course will have a web section on the UMass Canvas system. This will serve as the primary method of course communication and distributing course materials including readings, exams, and instructions for the final project.

Course assignments (homeworks and exams) will be administered through **Gradescope**, a teaching tool integrated with Canvas. Feedback on submitted assignments will also be provided via assignment rubrics through Gradescope.

Student Evaluation:

Grading:

Homeworks (3)	150 pts.	15%
Midterm Exams (2)	250 pts.	25%
Class Participation	100 pts.	10%
Final Project Proposal	50 pts.	5%
Final Project Draft Summary	50 pts.	5%
Final Project Peer Review	50 pts.	5%
Final Project Presentation	100 pts.	10%
Final Project	250 pts.	25%
Total	**1000 pts.**	

You are encouraged to track your grades on Canvas. I will post grades in timely manner (typically within 1 week of the due date) for all assignments.

Homeworks (50 pts. each). Over the semester, you will have weekly quizzes to complete outside of class time; these will be due **one week after posting**. The homeworks will test your comprehension of the reading and course material and give you practice with exam-like questions. They will be open-note, and you can complete these with classmates, but you must turn in your own work. They will be administered and graded through Gradescope.

Midterm exams (250 pts.). There will be two midterm exams, each 125 pts. – one covering material in Unit 1 and the second covering material in Unit 2. The exams will comprise a mix of multiple choice and short answer questions.

A make-up examination will only be provided in EXTREME CIRCUMSTANCES and will require documentation. If you know that you will need to miss the midterm, please contact me as soon as possible to schedule a make-up exam. It is the student's responsibility to notify the instructor of a missed exam and schedule a make-up. Significant documentation will be necessary (e.g. note from doctor, courthouse or judge, funeral director).

Class Participation (100 pts. cumulative). This class is designed to be as much a conversation about emergent research in ocean biogeochemistry as a lecture. To that end, attendance is required and you are strongly encourage to participate in class! Points will be deduced from the students' Class Participation score for > 3 unexcused absences or a continued pattern of not participating in lectures and discussions. The instructor will contact students in advance of any participation points being deducted.

Final Project. The final project is writing a *critical evaluation* – a review and summary of an aspect of/outstanding question ocean biogeochemistry of interest to you and related to your research. This project will be written following scientific manuscript styles (Abstract, Introduction, Results, Discussion, Conclusions) and must be fully referenced.

The final project is divided across multiple assignments:

• A **proposal** is due in October. This 1-paragraph document summarizes the research question/area and outlines how the critical evaluation will address this. It is worth **50 points**.

• A **two-page draft summary** is due in November. This document will expand upon the draft topic and must include one visualization/figure. It is worth **50 points**.

• A **peer-review file** of a peer's draft summary is due the following week. Students will read one draft summary produced by their fellow student(s) and provide constructive feedback to guide their future work. The review is worth **50 points**.

• An **in-class presentation** on the critical evaluation will be made on December 9th. The presentation format will be follow conference talks, with 12 minutes of presentation time followed by 3 minutes for audience Q&A. The presentation is worth **100 points**.

• A **final project paper** is due at the end of the semester. This ten-page document will include multiple display items and a response to review file based on the prior peer review. The final project paper is worth **250 points**.

Late Assignments and Extensions policy:
Homeworks will be accepted up to 1 week late with a 50% penalty (10% per 24 hours late after the initial deadline). Other assignments will **not** be accepted late for credit without prior arrangement.

Grading scale:

Letter Grade	percentage
A	93-100%
A-	90-92%
B+	87-89%
B	83-86%
B-	80-82%
C+	77-79%
C	73-76%
F	< 73%

Any fractional percentages will be rounded to the nearest whole number (0.1-0.4 will be rounded down, 0.5-0.9 will be rounded up).

Electronic Devices

Electronic mobile devices (e.g., cell phones, tablet computers, laptops) ***are required*** for full participation in this class for course-related activities. The use of mobiles devices must be in a manner that does not distract from the student's and the students' around them learning or ability to focus on class material.

Excused Absences

If you are absent from class and have an illness, family emergency or other obligation, you may ask for an excused absence. **You are responsible for asking that your absence be excused.** You may do this by:

- Emailing the instructor;
- In most cases, you should also report your absence to the Dean of Students here: https://cm.maxient.com/reportingform.php?UMassBoston&layout_id=24.
-Absences for religious observations should be reported by filling out the same excused absence form (requires 2-weeks' notice).
-For this semester, absences due to COVID (student, family, mental health) are considered excused absences whether short or long term and do not need to be reported or approved by the Dean of Students. However, you still must email the instructor so we know which dates you are excused from class.

If you have an excused absence, you are still responsible for the material. Course lecture materials will be posted to Canvas and students who have an excused absence will be required to catch up on these materials in a timely manner.

Penalty-free extensions to assignments will only be provided with advance notice of an excused absence. Any requests for extension submitted after the due date of the assignment will be denied.

Inclement Weather, Emergency Policy, and Continuity of Education

In the event that a snowstorm, other inclement weather or emergency presents a risk to commuting faculty, staff, students, and visitors, an appropriate campus response will be determined by the Chancellor, the Provost, the Vice Chancellor for Administration and Finance and the Vice Chancellor for Student Affairs. Campus closing procedures differ depending on the timing of the decision to close and the expected length and severity of the inclement weather or situation. The essential factor in the decision is the safety of those commuting to and from the campus. However, inclement weather or situations affecting only a limited number of commuters will not usually result in a campus closing. Always use sound personal judgment and knowledge of local weather and traffic conditions when deciding your commute to and from campus. If you are unable to make it campus safely, contact the professor and TA as soon as possible.

The UMass Boston ALERT System will communicate campus closure via text and email. To sign-up for the UMass Boston Alert System please go to https://www.getrave.com/login/umb. The UMass Boston website, http://www.umb.edu, will post announcements. The main switchboard, (617) 287-5000, will carry voicemail announcements.

University Closed / Classes Canceled means: All Harbor Campus classes and events canceled; All offices and the Library closed; and Essential and assigned snow day personnel to report at scheduled time, ***which means ENVSCI 670 will NOT have class, check email and/or Canvas for alternative assignment.***

Delayed Opening / Early Morning Classes Canceled *means*: Essential and assigned snow day personnel to report at scheduled time; All other staff to report to work at 10:00 a.m.; All harbor campus morning classes and events are canceled; and Campus will open for classes and events at 11:00 a.m., ***which means ENVSCI 670 will hold class.***

Evening Classes Canceled means**:** All harbor campus classes and events beginning at or after 4:00 p.m. are canceled; All offices and Library closed at 4:00 p.m., ***which means ENVSCI 670 will hold class.***

I am committed to continuity of education during inclement weather. In the case of a school closing, I will send out an email detailing an alternative assignment which may include an online or remote lecture (through Zoom) and/or assignment. Alternative assignments will be due 1 week after classes resume. If severe weather or its impacts make it difficult for you to complete these assignments, please let me know as soon as possible.

Accommodations

UMass Boston is committed to creating learning environments that are inclusive and accessible. If you have a personal circumstance that will impact your learning and performance in this class, please let me know as soon as possible, so we can discuss the best ways to meet your needs and the requirements of the course. If you have a documented disability, or would like guidance about navigating support services, contact the Ross Center for Disability Services by email (ross.center@umb.edu), phone (617-287-7430), or in person (Campus Center, UL Room 211). **To receive accommodations, students must be registered with the Ross Center and must request accommodations each semester that they are in attendance at UMass Boston**. For more information visit: https://www.umb.edu/academics/vpass/disability. Please note that the Ross Center will provide a letter for your instructor with information about your accommodation only and not about your specific disability.

Academic Integrity and Student Code of Conduct

Education at UMass Boston is sustained by academic integrity. Academic integrity requires that all members of the campus community are honest, trustworthy, responsible, respectful, and fair in academic work at the university. As part of being educated here, students learn, exercise, increase, and uphold academic integrity. Academic integrity is essential within all classrooms, in the many spaces where academic work is carried out by all members of the UMass Boston community, and in our local and global communities where the value of this education fulfills its role as a public good. Students are expected to adhere to the Student Code of Conduct, including policies about academic integrity, delineated in the University of Massachusetts Boston Graduate Studies Bulletin, Undergraduate Catalog, and relevant program student handbook(s), linked at www.umb.edu/academics/academic_integrity.

Special Statement on Plagiarism and Artificial Intelligence (AI) Tools

Familiarize yourself with definitions and examples of plagiarism (consult https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism). The consequences for plagiarism according to the Code of Conduct are severe and can in the worst cases lead to suspension from the university.

AI is prohibited: In this class, all work submitted by students must be generated by the students themselves, whether working individually or in groups. Students should not have another person or entity do the writing of any portion of an assignment; this includes hiring a person or a company to write assignments and using AI tools like ChatGPT. If students are unsure about whether a source is appropriate to use in the assignment, they should contact the instructor.

Student Support Statement

Subject tutoring and writing assistance are available through the Office of Academic Support Programs (287-6550 or www.academicsupport.umb.edu).

Health, Wellbeing, and Success

UMass Boston is a vibrant, multi-cultural, and inclusive institution committed to ensuring that all members of our diverse campus community are able to thrive and succeed. The university provides a wide variety of resources to support students' overall success. As we continue to deal with the evolving impacts of the COVID-19 pandemic, these resources are more important than ever.

- Are you in emotional distress? Call 617.287.5690 to speak with a licensed clinician 24/7 who can offer support, crisis recommendations, and assistance with finding resources.
- Have a campus question or issue? Use Here4U in the UMass Boston app or via www.umb.edu/here4U.
- Need help with food insecurity, legal consultation, financial counseling or emergency supplies? Contact U-ACCESS (https://www.umb.edu/campus-life/current-students/u-access/)
- Want advice in navigating a university or life situation? Contact the Dean of Students Office at www.umb.edu/deanofstudents.

- Want to connect with housing and food insecurity support, student life groups and events, or recreation activities? Visit www.umb.edu/life.
- Want to access resources specifically for immigrant-origin, DACA, TPS, and undocumented students? Visit www.umb.edu/immigrant.
- Looking for additional identity-based community support? Find more resources at www.umb.edu/identity-support
- Want to make the most of your academic experience? Visit www.umb.edu/academics/vpass/academic_support.
- Unable to attend class on a specific date or participate in an exam or class requirement due to a religious observance? Fill out the excused absence form (requires 2-weeks' notice) to request religious accommodation at www.umb.edu/religiousabsence.

Detailed Course Outline (Fall 2025)

Week	#	Day	Date	Lecture Topic	Reading	Assignments
Unit 1: Ocean mass balance						
1	1	Tu	2-Sep	1 - Introduction: Why is the ocean salty?	S&G Chapter 1	
	2	Th	4-Sep	2 - Mass balances and residence times	Farmer et al. (2024) Section 1	
2	3	Tu	9-Sep	3 - Properties of water	E&H Chapter 2	
	4	Th	11-Sep	4 - Chemical speciation	Millero (2013)	HW 1 posted
3	5	Tu	16-Sep	5 - Gas exchange	S&G Chapter 3	
	6	Th	18-Sep	6 - Salinity and ocean circulation	Talley (2013)	HW 1 due
4	7	Tu	23-Sep	**7- Unit 1 Review Session**		
	8	Th	25-Sep	**8- Midterm Exam 1 - Online, due by 11:59pm Friday 9/26**		
Unit 2: Internal cycles						
5	9	Tu	30-Sep	9 - Photosynthesis and primary production	S&G Chapter 4	
	10	Th	2-Oct	10 - Export, regeneration and burial	S&G Chapter 4	HW 2 posted
			2-Oct	**Introduction to the final project**		
6	11	Tu	7-Oct	11 - Inorganic carbon chemistry-1	S&G Chapter 8	
	12	Th	9-Oct	12 - Inorganic carbon chemistry-2	S&G Chapter 8	HW 2 due
7	13	Tu	14-Oct	13 - Nitrogen-1	S&G Chapter 4.1, 4.2, 5.1, 5.3	Final project topic due
	14	Th	16-Oct	14 - Nitrogen-2	Sigman & Fripiat (2019)	HW3 posted
8	15	Tu	21-Oct	15 - Phosphorous	S&G Chapter 5.1, 5.3	
	16	Th	23-Oct	16 - Bioactive trace elements	Horner et al. (2021)	HW3 due
9	17	Tu	28-Oct	**17- Unit 2 Review Session**		
	19	Th	30-Oct	**Midterm Exam 2 - Online, due by 11:59pm Friday 10/31**		
Unit 3: Ocean Biogeochemistry and Climate						
10	18	Tu	4-Nov	18 - Chemical evolution of Earth	Ridgwell and Zeebe (2005)	
	19	Th	6-Nov	19 - Organisms, evolution and species successions	S&G Chapter 7, 8.1, 9.1	
11	20	Tu	11-Nov	20 - Efficiency of the biological pump 1: f-ratios	Eppley and Peterson (1979)	
	21	Th	13-Nov	21 - Efficiency of the biological pump 2: preformed nutrients	Ito and Follows (2005)	Final project 2-pager due
12	22	Tu	18-Nov	23 - Ocean biogeochemical provinces	S&G Chapter 4	
	23	Th	20-Nov	24 - Ocean controls on CO2: long term	E&H Chapter 8	Peer review due
13	24	Tu	25-Nov	25 - Ocean controls on CO2: short term	S&G Chapter 10.4; Sigman et al. (2010)	
		Th	27-Nov	**HOLIDAY - no class**		
14	25	Tu	2-Dec	26 - Future biogeochemistry 1: ocean acidification	Doney et al. (2009)	
	26	Th	4-Dec	27 - Future biogeochemistry 2: climate engineering	Bach et al. (2019)	
15	27	Tu	9-Dec	**Final project presentations**		
	28	Th	11-Dec	No class; work on final project		
				Final Project - 10 pager due by 11:59pm Monday 12/17		